
Energy For Our Future
Conference Summary
Prepared by Debbie Cook
For SCAG RCP
March 27, 2006

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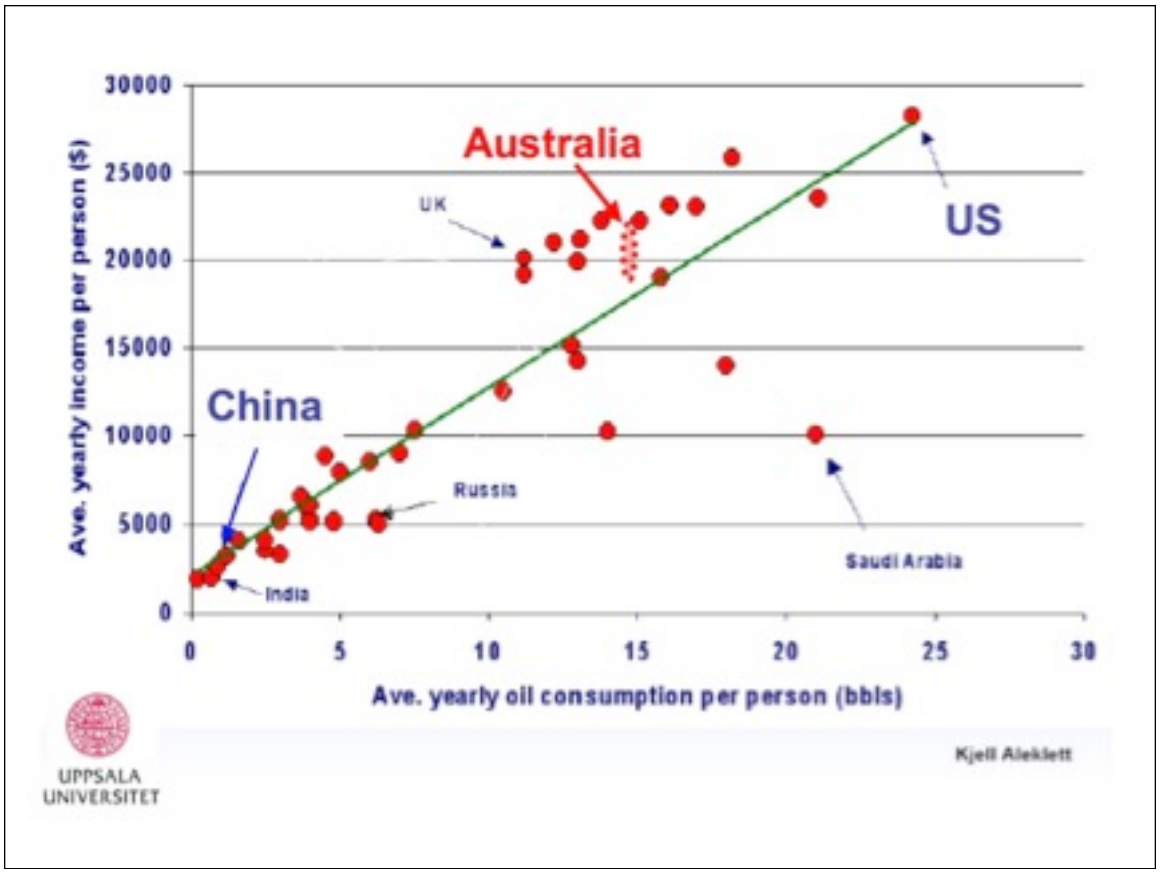
Randy Udall,

- Director of Community Office for Resource Efficiency, Aspen, CO
- Co-founder, ASPO-USA



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China was a net oil exporter until a decade ago, but by 2030, China's oil imports may equal American imports now.

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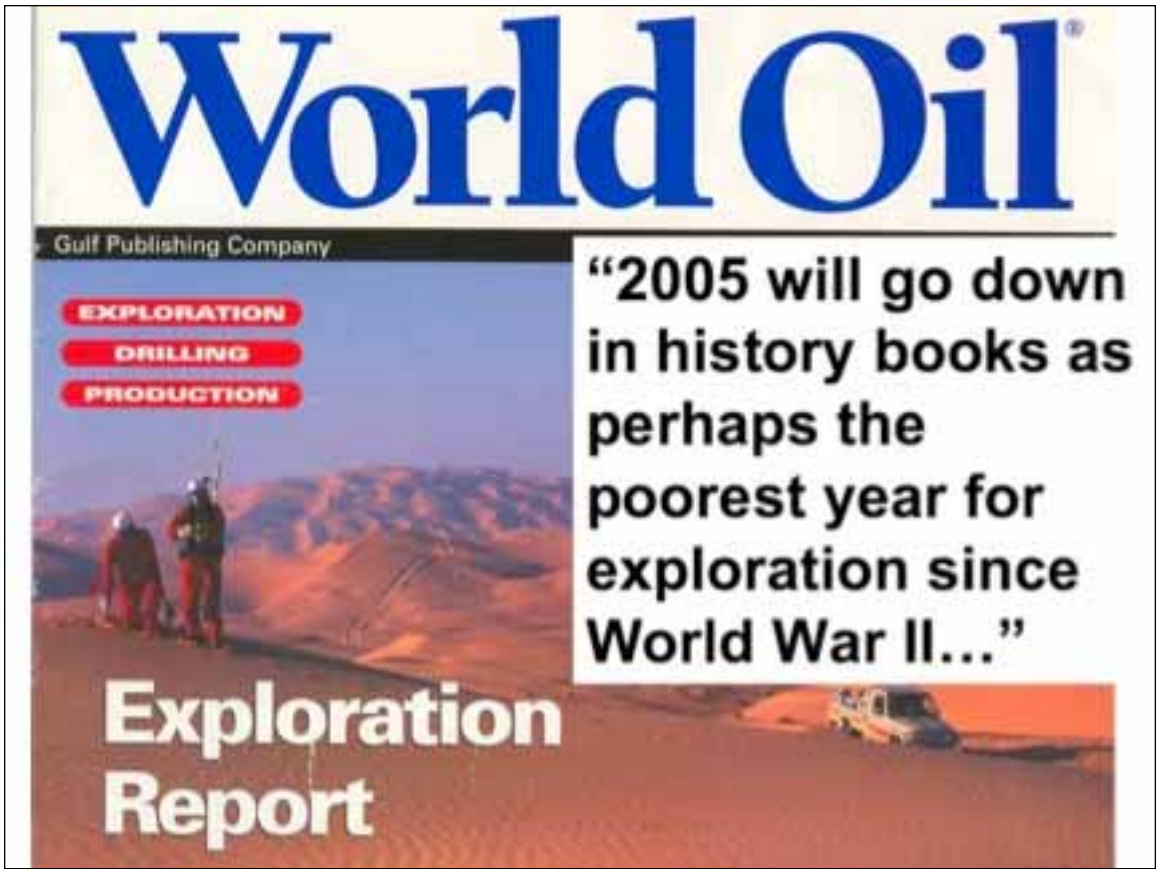
World Oil
Gulf Publishing Company
EXPLORATION
DRILLING
PRODUCTION
"2005 will go down in history books as perhaps the poorest year for exploration since World War II..."
Exploration Report

7


The oiloholics
CHINA
The Economist

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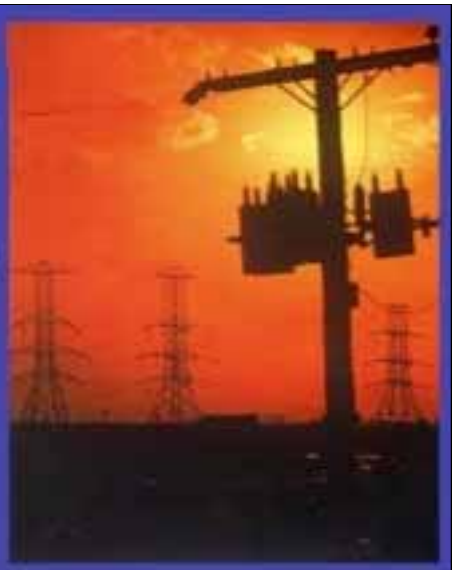
Energy is our most precious resource, the greatest 20th century invention. Mobility, electricity, technology, telecommunications, agriculture, medicine…

Energy is the original currency, the source of wealth.



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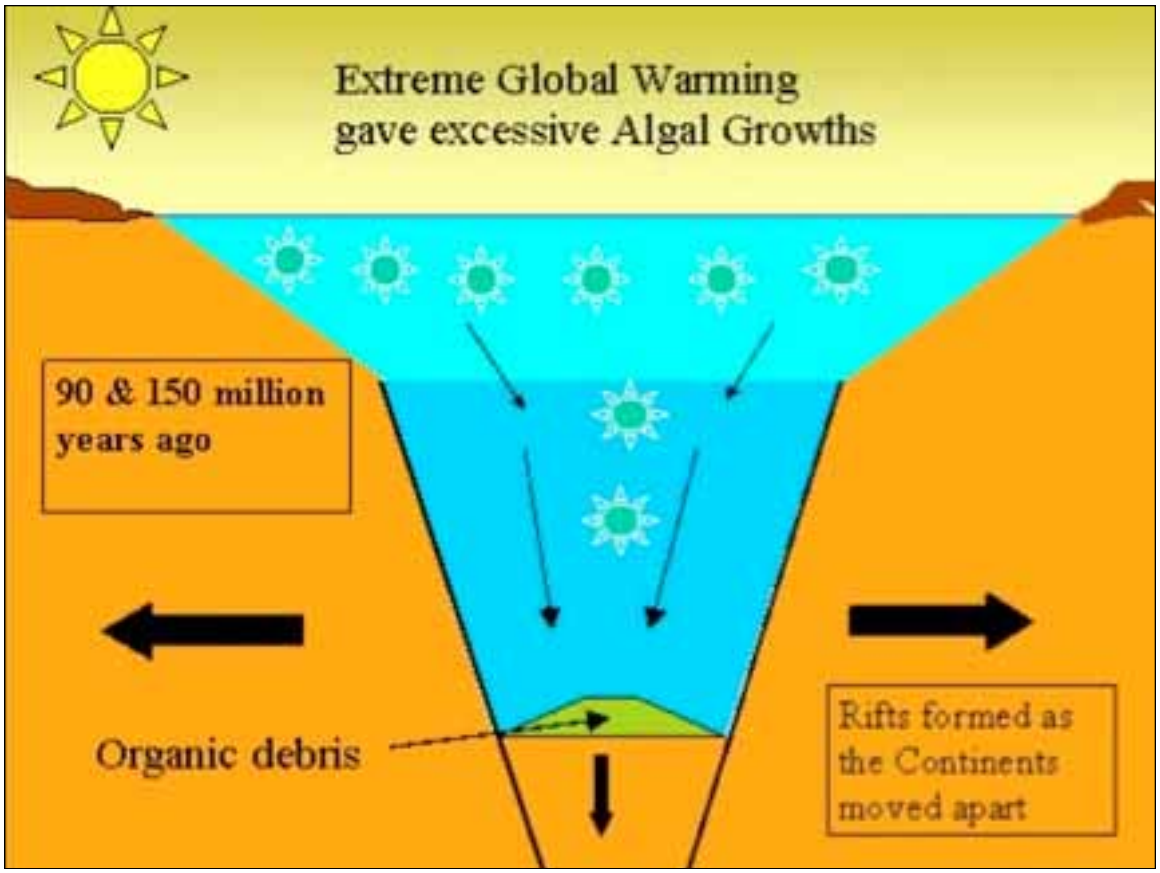
Jeremy Gilbert

- Former Chief Petroleum Engineer, British Petroleum
- Managing Director of Barrelmore Ltd, Ireland

Do we really appreciate our oil?

- Prices (per pint)
  - Gasoline: $0.30
  - Milk: $1.00
  - Bottled Water: $1.50
  - Orange Juice: $0.50
  - Cappuccino: $15.00
- Daily Consumption (per person)
  - Food 2,300 k cal
  - Oil-based energy >100,000 k cal


Extreme Global Warming
gave excessive Algal Growths
90 & 150 million
years ago
Organic debris
Rifts formed as
the Continents
moved apart

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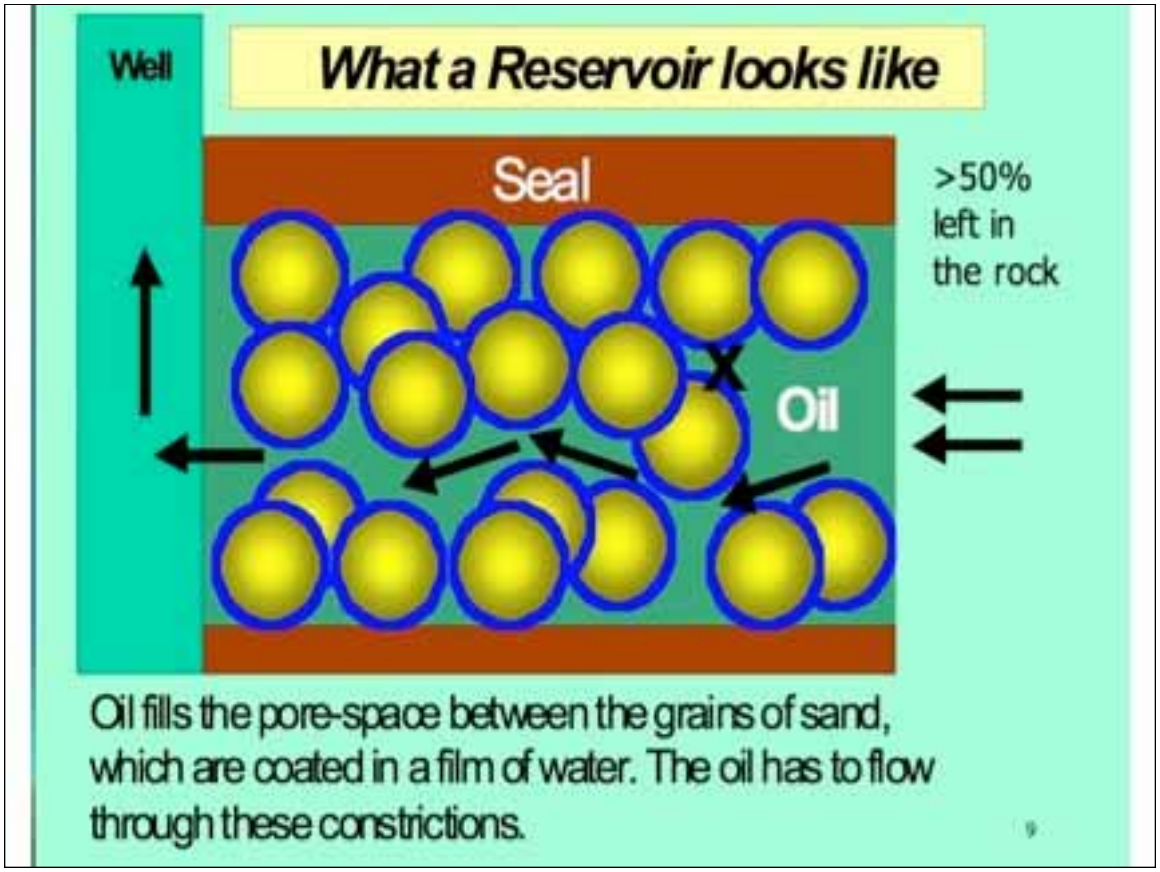
Well
What a Reservoir looks like
Seal
>50%
left in
the rock
Oil
Oil fills the pore-space between the grains of sand,
which are coated in a film of water. The oil has to flow
through these constrictions.

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Why is there confusion?

Oil companies reported Reserves to meet strict Stock Exchange rules

- Designed to prevent fraudulent exaggeration
- Smiled on conservative reporting

Discoveries under-reported, revised upwards later

- Comforting but misleading image of steady growth
- No conspiracy - just simple commercial prudence

OPEC over-reported

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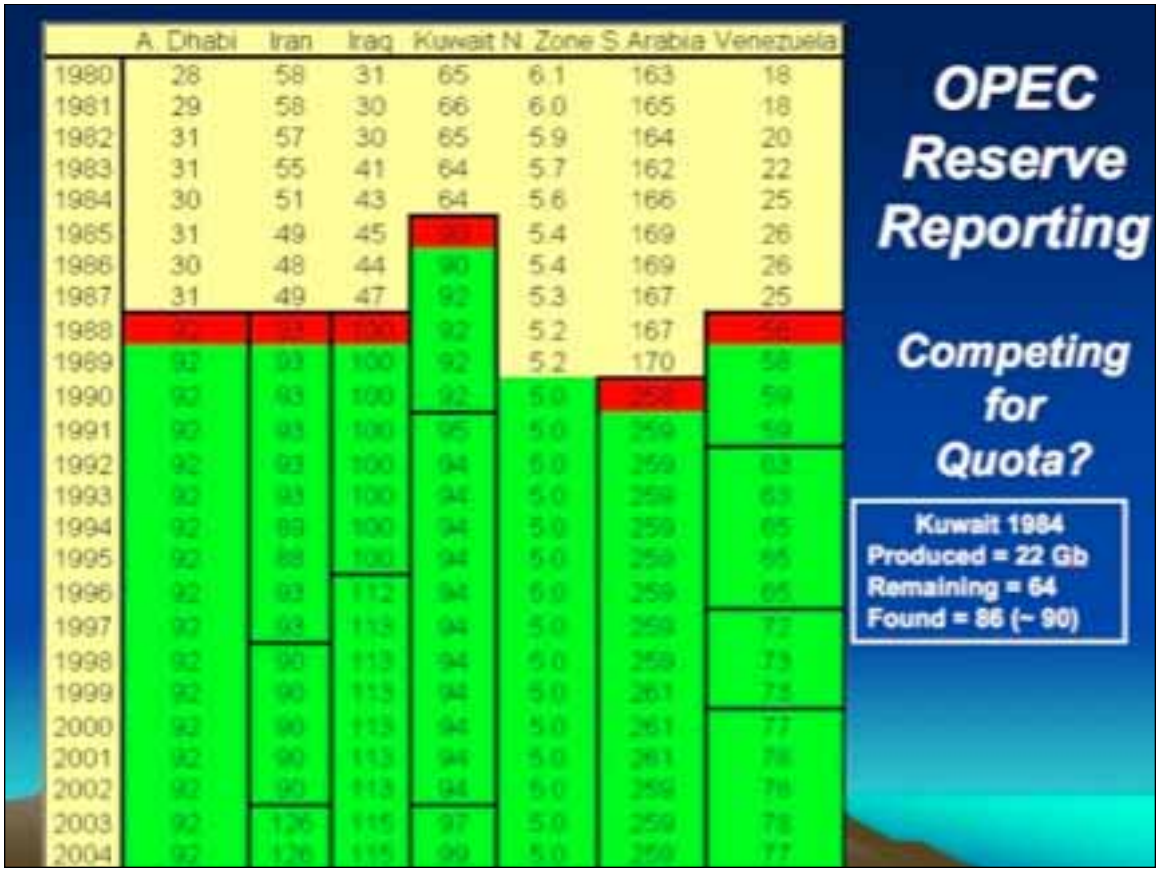

OPEC Reserve Reporting

Competing for Quota?

Kuwait 1984
Produced = 22 Gb
Remaining = 64
Found = 86 (~ 90)

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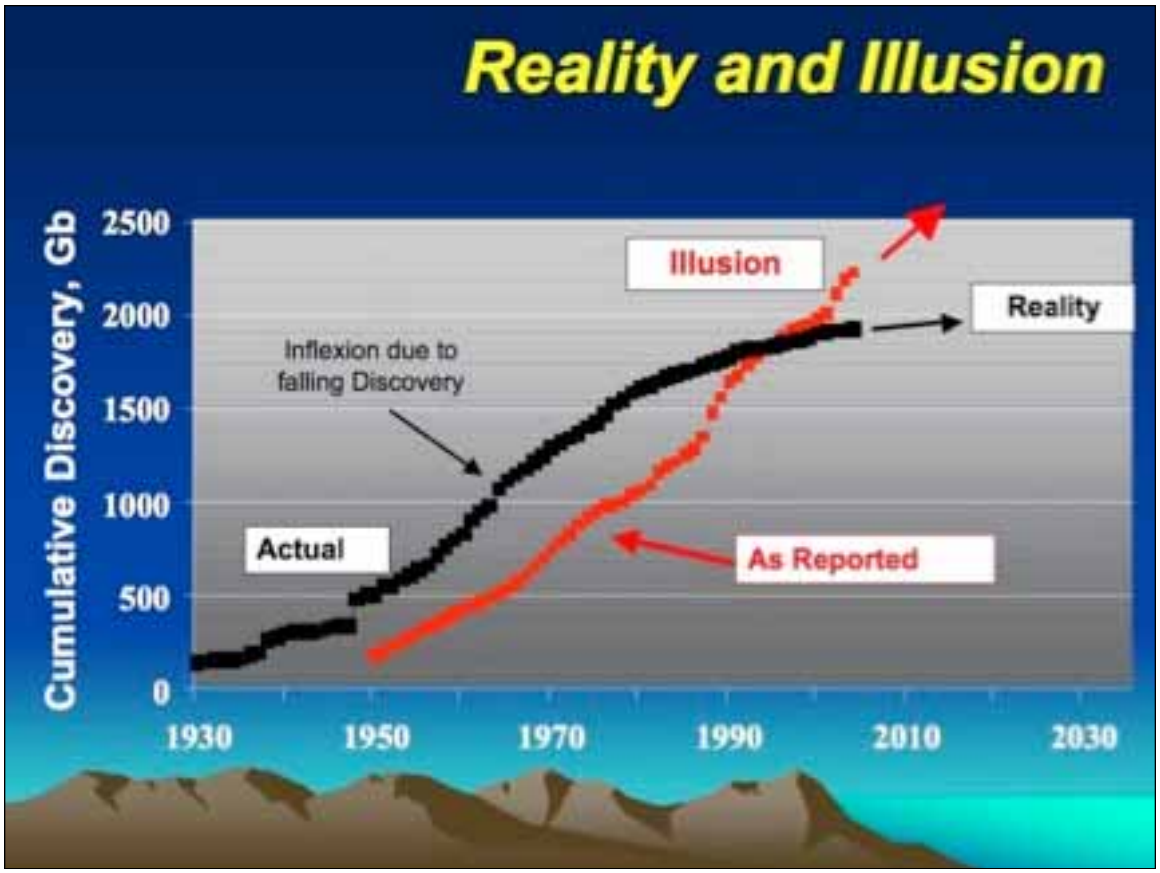
Reality and Illusion
Cumulative Discovery, Gb
2500
2000
1500
1000
500
0
1930
1950
1970
1990
2010
2030
Illusion
Reality
Inflexion due to
falling Discovery
Actual
As Reported

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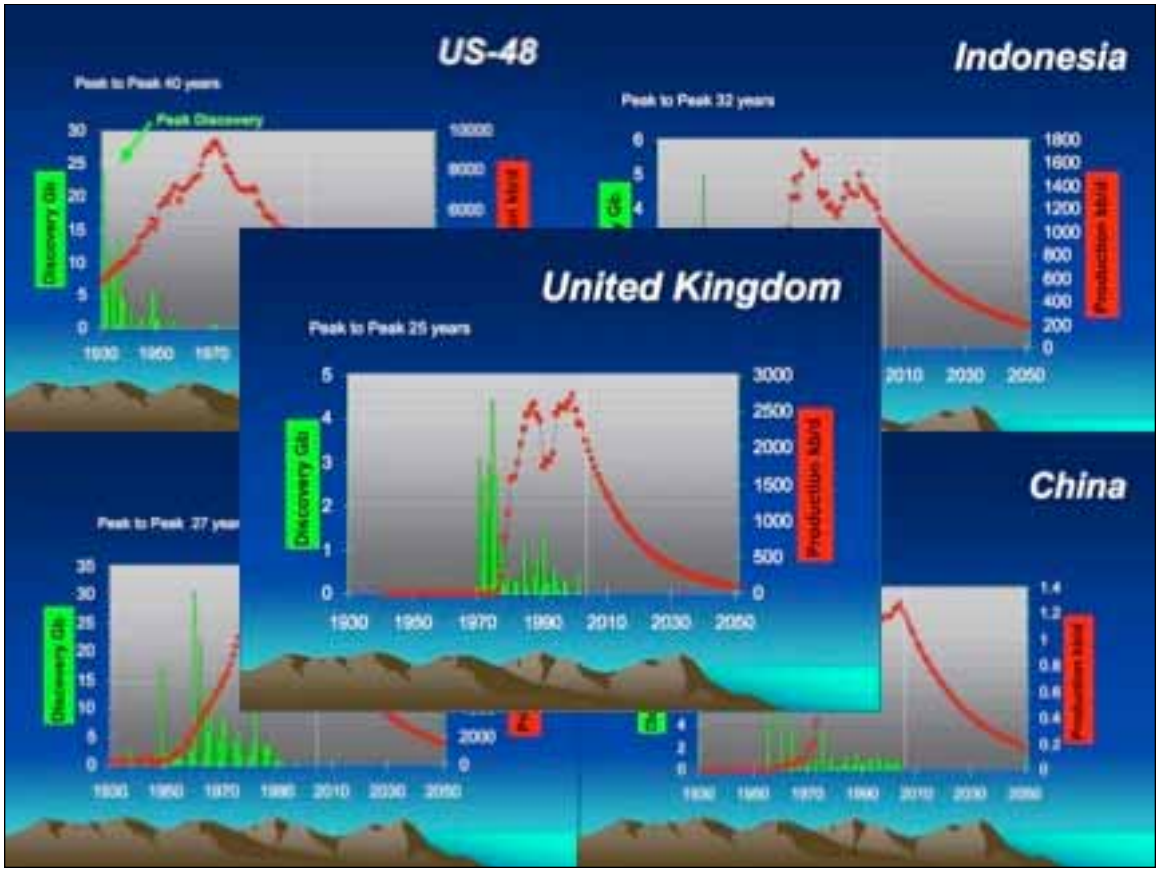
US-48
Indonesia
United Kingdom
China
Peak to Peak 25 years
Peak to Peak 32 years
Discovery Gb
Production kb/d

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53 countries are past peak

Pre-1970 - Austria, Germany

1970s - Venezuela, Bahrain, Ukraine, Libya, USA, Turkmenistan, Canada, Iran, Romania, Indonesia, Trinidad, Brunei, Algeria

1980s – Tunisia, Chile, Albania, Peru, Cameroon, Brazil, Hungary, Russia, France, Croatia, Netherlands

1990s – Turkey, Dubai, Pakistan, Papua, Syria, Egypt, Gabon, Argentina, Angola, Sharjah, Uzbekistan, UK, Colombia, Yemen

2000s – Mexico, Nigeria, Norway, N. Zone, Oman, India, Qatar, Malaysia, Australia, Ecuador, Denmark, Congo, Italy

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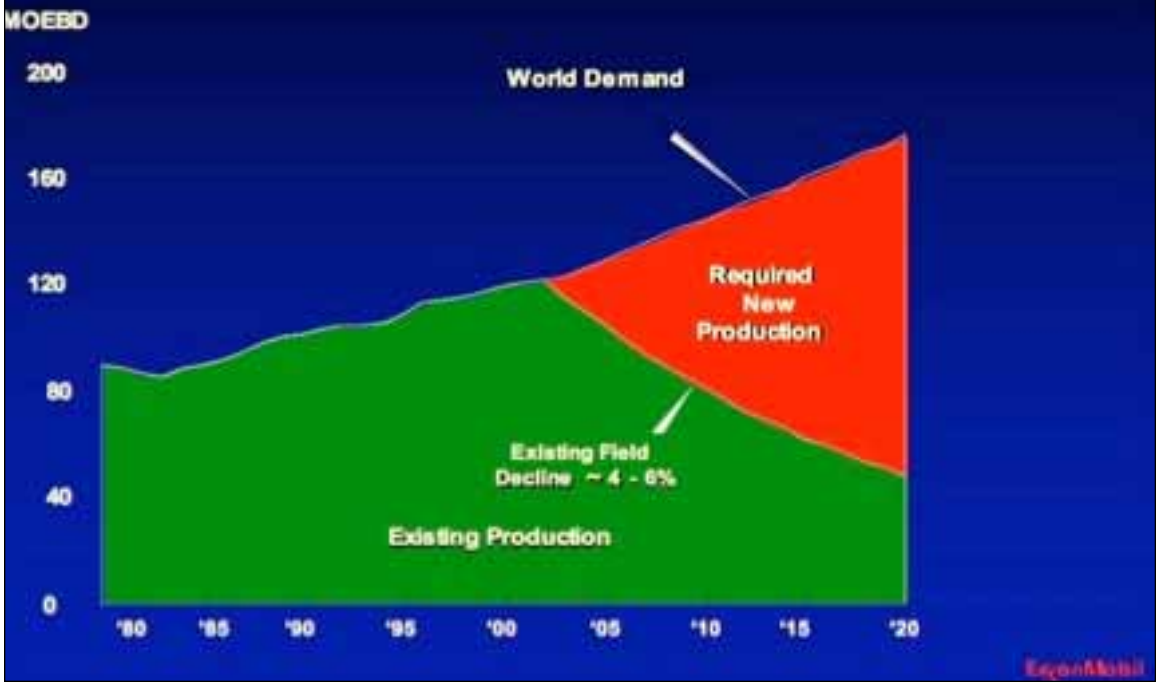
Meeting the Challenge

Industry Outlook - Oil & Gas Demand/Supply



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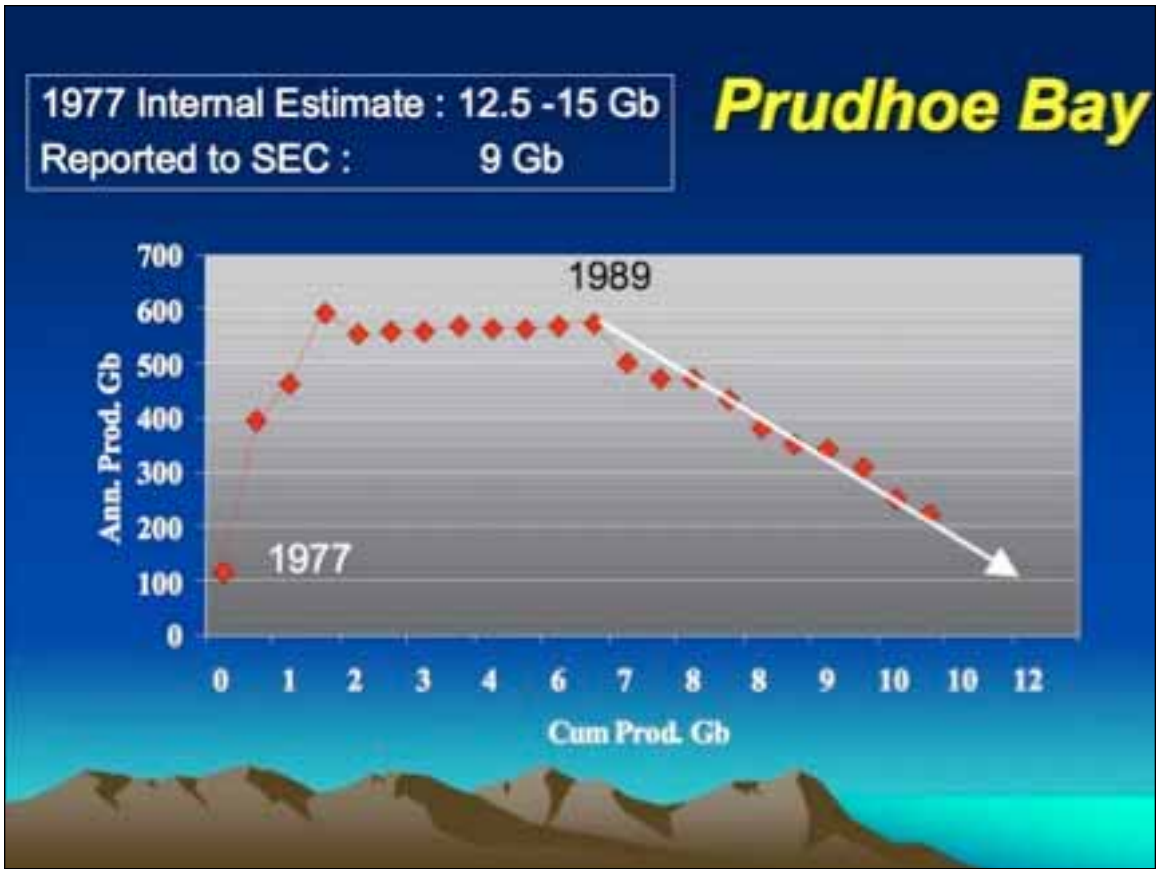
1977 Internal Estimate : 12.5 -15 Gb
Reported to SEC : 9 Gb
Prudhoe Bay
1989
1977
Ann. Prod. Gb
Cum Prod. Gb
700
600
500
400
300
200
100
0
0 1 2 3 4 6 7 8 8 9 10 10 12

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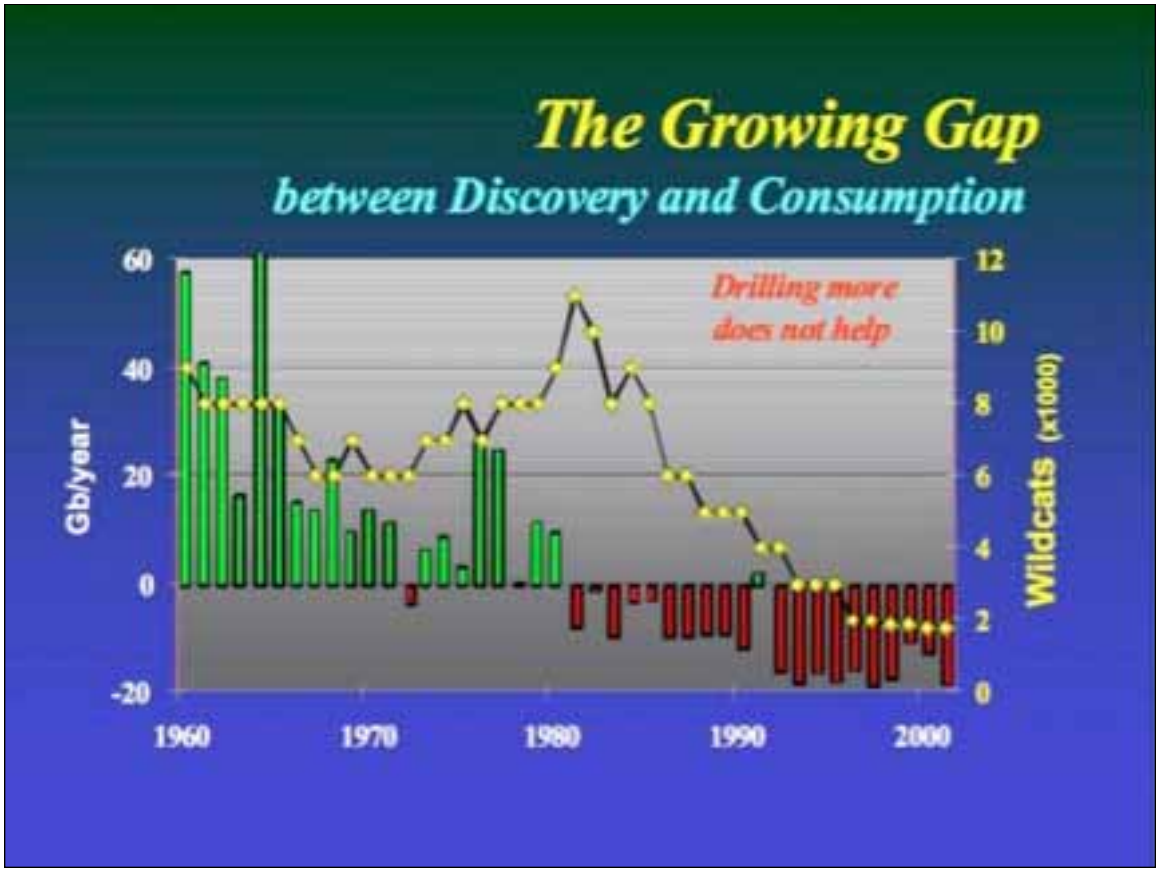
The Growing Gap
between Discovery and Consumption
Drilling more does not help
Gb/year
Wildcats (x1000)
60
40
20
0
-20
12
10
8
6
4
2
0
1960
1970
1980
1990
2000

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The Unfillable Gap?

- Demand increasing at ~3 mmbd/year
- Offtake decline (existing fields) ~ 4 mmbd/year
- So, new sources of 7 mmbd needed each year
- Recent typical discovery rate of <8 b bbls/year adds only about 1.5 mmbd each year

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Roger Bezdek

- President and Founder, Management Information Services
- Expert in Energy Market Analysis and Energy Forecasting

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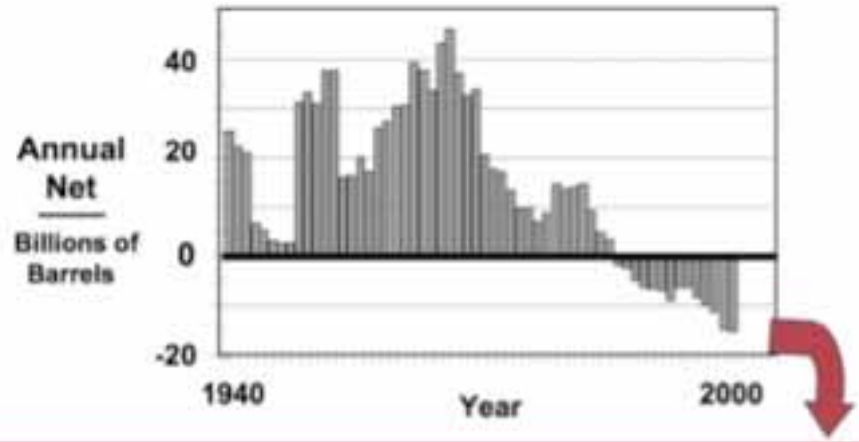
We're finding much less than we're consuming.



The world's first forced energy transition

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When?

No one knows for certain

Forecast	Source	
2006-2007	Bakhitari (Iran)	5 years
2007-2009	Simmons (U.S.)	
After 2007	Skrebowski (U.K.)	
2008	Campbell (Ireland)	
Before 2009	Deffeyes (U.S.)	
Before 2010	Goodstein (U.S.)	
After 2010	World Energy Council	5-10 years
2012	Weng (China)	
2016	Doug-Westwood (U.K.)	
After 2020	CERA (U.S.)	> 15 years
2031 or later	EIA (U.S))	

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LEARNING FROM U.S. NATURAL GAS

- **Experts overestimated North American natural gas reserves & future production as late as 2001.**
  - National Petroleum Council - 1999
  - DOE EIA - 1999
  - Cambridge Energy Research Associates - 2001
- **U.S. natural gas production is now in decline.**

- **Natural gas & oil geology are similar.**
- **If wrong on natural gas, what's the risk on oil?**

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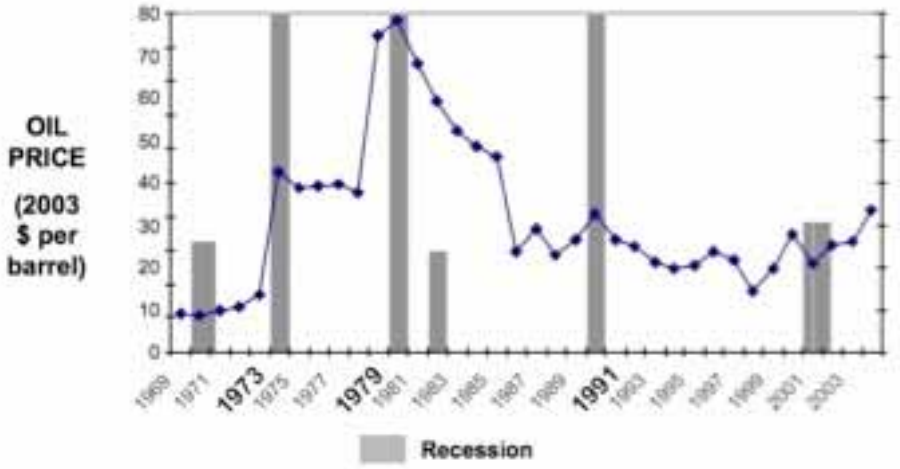
Oil PRICE INCREASES HAVE CAUSED U.S. RECESSIONS



Over 30 years, four recessions followed oil price spikes.

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Experience: Two Oil Interruptions

- Impacts of world oil production peaking are exemplified by the 1973 & 1979 oil interruptions.

  + Inflation
  + Unemployment
  + Recession
  + High interest rates

- 1973 & 1979 were relatively brief.

- World oil peaking impacts could last a decade or more.

The world has never faced a problem like oil peaking.

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CHARACERISTICS OF U.S. TRANSPORTATION FLEETS

Fleet	Size	Median Lifetime (Years)	Cost to Replace Half the Fleet (2003 $)
Automobiles	130 million	17	$1.3 trillion
Light Trucks, SUVs,etc.	80 million	16	$1 trillion
Heavy Trucks, Buses, etc.	7 million	28	$1.5 trillion
Aircraft	8,500	22	$.25 trillion

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MITIGATION OPTIONS

Focus: Technologies that can be implemented now for liquid fuels applications……Commercial or near-commercial

Options Considered:

- Vehicle Fuel Efficiency
- Gas-To-Liquids (GTL)
- Heavy Oil / Oil Sands
- Coal Liquefaction
- Enhanced Oil Recovery (EOR)

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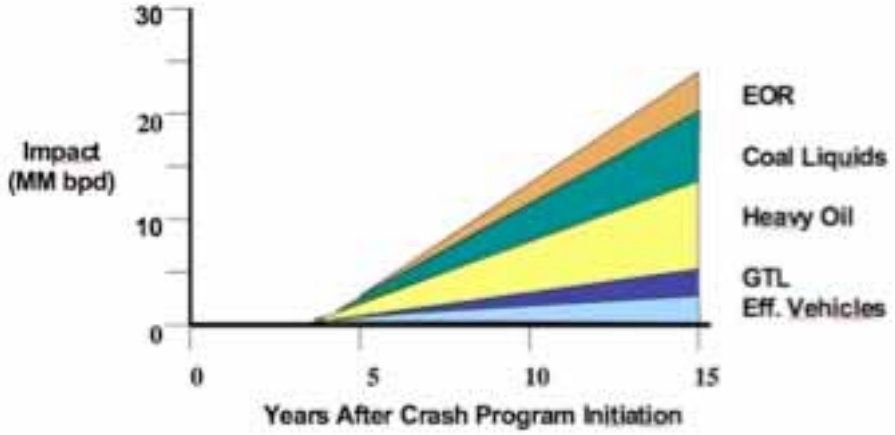
SUM OF WEDGES



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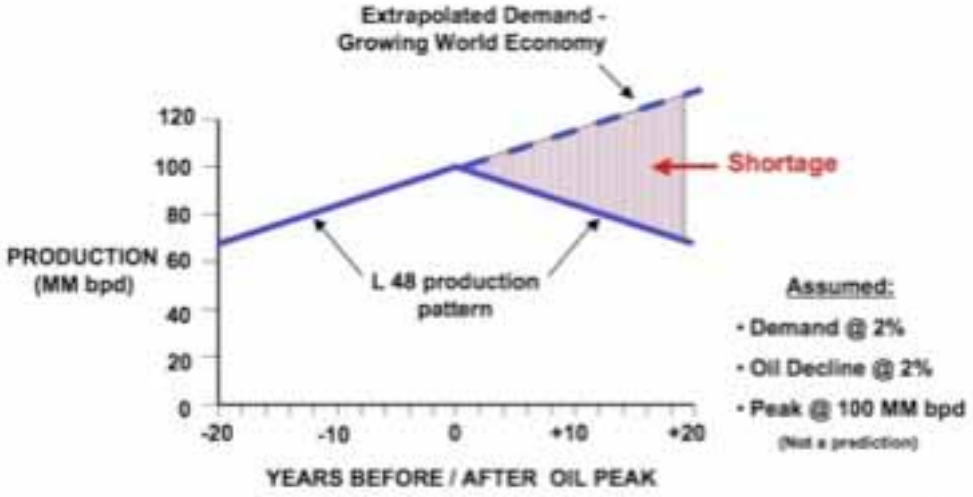
WORLD OIL SUPPLY & DEMAND:

LOWER 48 PRODUCTION PATTERN & EXTRAPOLATED DEMAND GROWTH



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THREE MITIGATION SCENARIOS

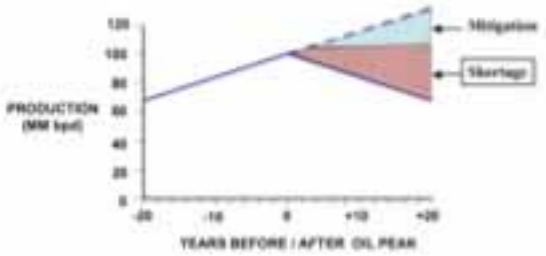
- Scenario I - No action until peaking occurs
- Scenario II - Mitigation started 10 years before peaking
- Scenario III - Mitigation started 20 years before peaking

Assumptions:

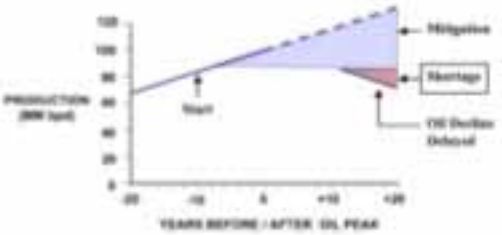
- All mitigation initiated immediately
- Crash program implementation

Optimistic limiting case

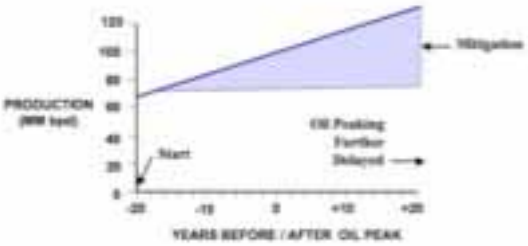
SCENARIO I: MITIGATION @ PEAKING



SCENARIO II: MITIGATION 10 YEARS BEFORE



SCENARIO II: MITIGATION 20 YEARS BEFORE



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Why so long to mitigate?

- Energy is inherently very large scale.
  - It's not computers or electronics
  - No magic bullets, only poison pills
- Long time to build capacity & savings
- Long lifetimes
- Inherently expensive

Options not in the study may contribute locally but will not change the overriding world problem.

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SOME ISSUES

- Skilled workers & industrial capacity worldwide are in short supply for the level of effort described herein.
- Massive commercial crash programs are rare. Startup will almost certainly be much slower than assumed in this analysis.
- Some countries may delay, others will proceed rapidly with mitigation. China may have started (Canada, Venezuela).
- It is not clear how environmental protection will fare if there is widespread joblessness, high inflation & severe recession.

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LOOK AGAIN AT THE SHORTFALL

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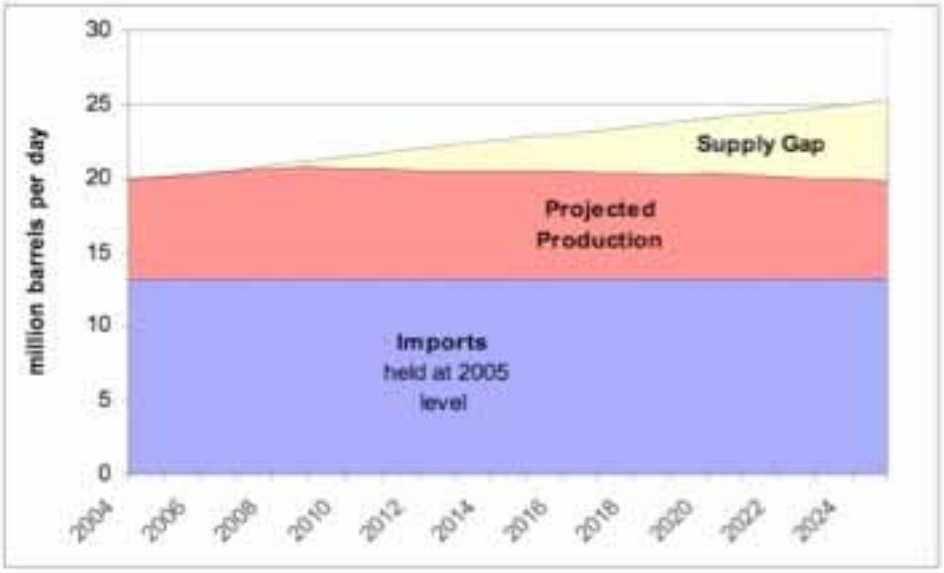
PRES. BUSH: "REDUCE OIL IMPORT DEPENDENCE"
FIRST THING TO DO: STOP DIGGING!



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THREE POLICY RECOMMENDATIONS

1. The federal government should increase vehicle fuel efficiency standards and initiate substitute liquid fuels mitigation options.

2. State and local governments should encourage smart growth, telecommuting, mass transit, and other transportation fuel efficiency options and facilitate and expedite the siting of substitute liquid fuels plants.

3. All levels of government should educate the public to the fact that we face a serious liquid fuels problem that will require controversial and unpopular measures to reduce demand and increase supply.

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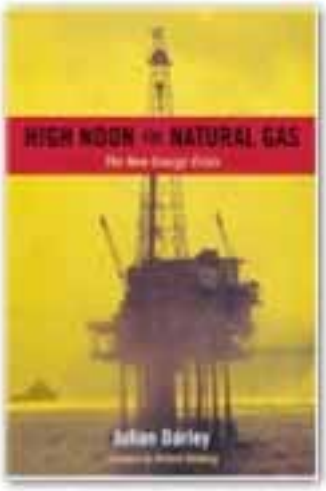
Julian Darley



- Author, *High Noon for Natural Gas*
- Founder, Global Public Media and Post Carbon Institute

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Energy Hunger

- US Gas Consumption
  - Natural Gas ~ 50 - 60 billion cubic feet per day (~22 Tcf/yr)
    - US imports 15-17%
      - Most from Canada + 2% LNG
  - Oil >21 million barrels per day (7bnb/yr)
    - US imports ~60%, rising to 70-80% by 2025?
- World consumption
  - Oil ~84 mb/d (~31 bnb/yr)
  - Natural gas ~ 200 bcf/d (~80 Tcf/yr)

Post Carbon Institute
www.postcarbon.org

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Peaking Of Natural Gas Is A More Critical Issue

- Natural gas reserve data very sketchy (worse than oil).
- Natural gas, a vapor, declines faster than oil.
- Too many key gas producing regions/key fields in decline.
  - USA
  - Western Siberia
  - Indonesia
  - Canada
  - United Kingdom
- Too many future sources are barely drilled:
  - Saudi Arabia's non-associated gas
  - Qatar and Iran's North Field/South Pars
- Too many exploration basins are undrilled:
  - Arctic gas
  - Most deepwater regions

SIMMONS & COMPANY INTERNATIONAL

Simmons, Matt. February 21, 2006. Lecture to Kansas City Chamber of Commerce
http://www.simmonsco-intl.com/files/Kansas%20City%20Chamber%20of%20Commerce.pdf

Post Carbon Institute
www.postcarbon.org

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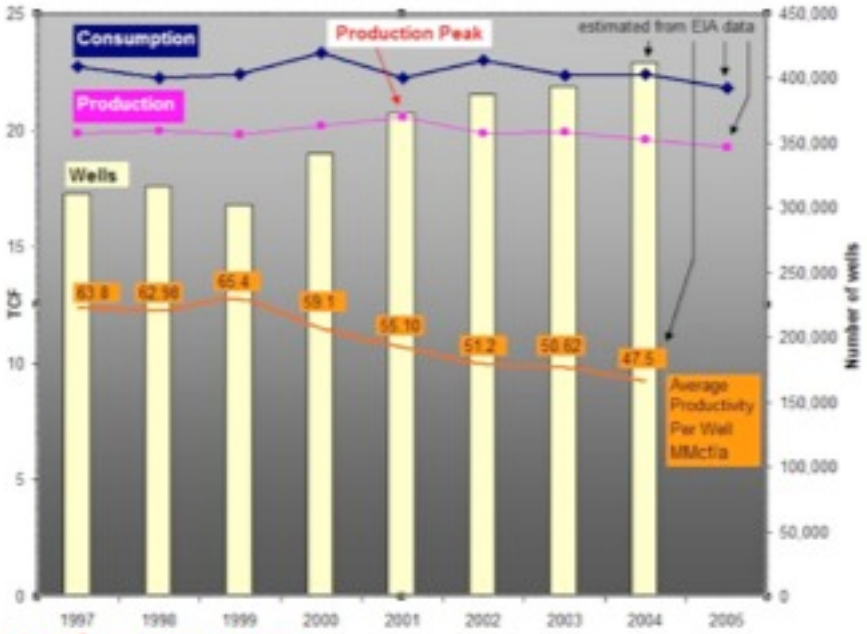
The Decline of US Gas



Post Carbon Institute
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Post Carbon Institute from EIA Data

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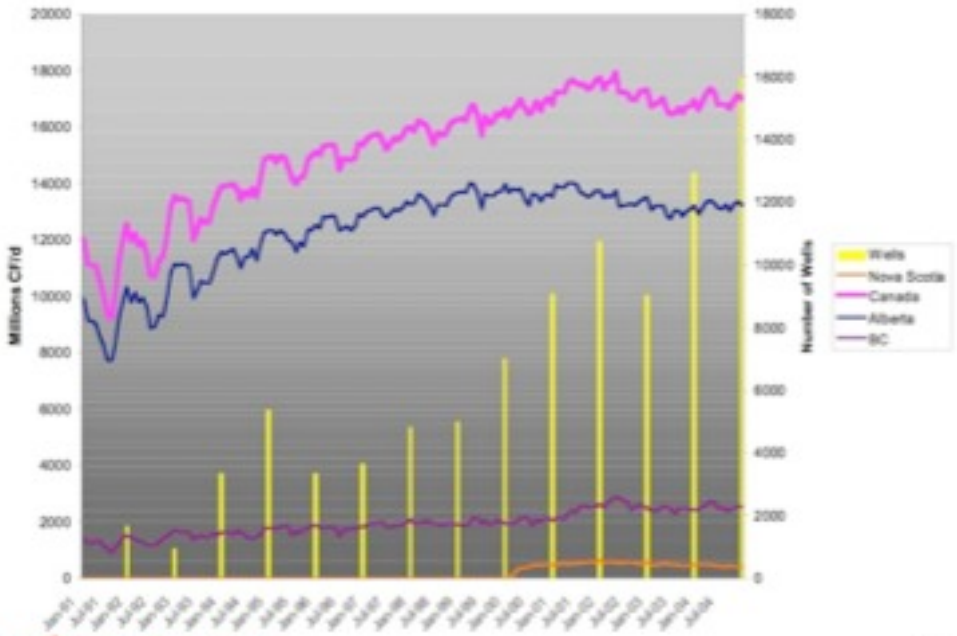
Canadian Gas Production



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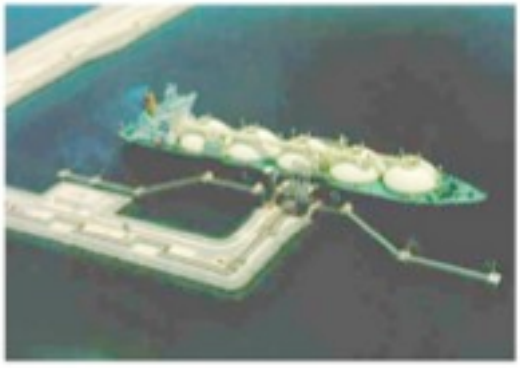
LNG Tankers



http://www.hydrocarbons-technology.com/projects/rasla/flarnrell/images/img3.jpg

http://www.qatargas.com.qa/corporate-profile/Images/history-10.jpg

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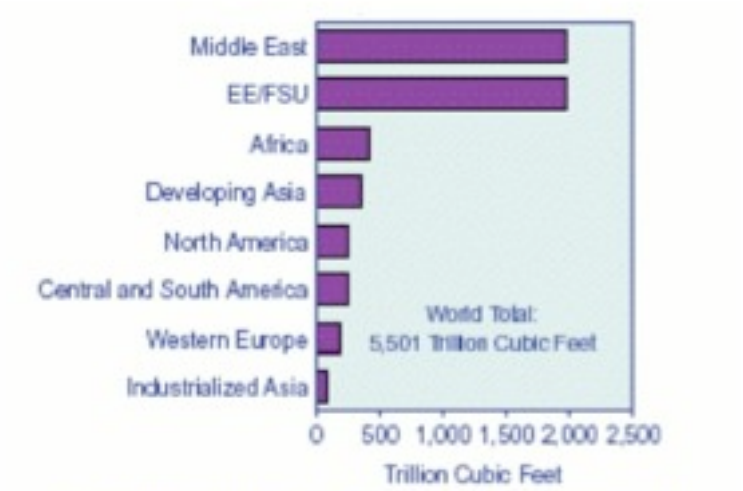
World Natural Gas Reserves
by Region (as of Jan 1, 2003)



Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 100, No. 52 (December 23, 2002), pp. 114- 115.

ftp://ftp.eia.doe.gov/pub/pdf/international/0484(2003).pdf

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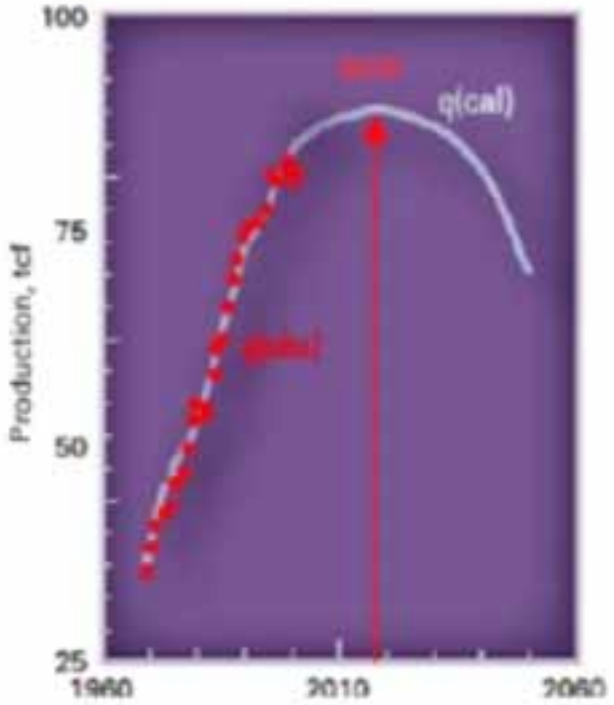
World Gas Production Peak?



Conventional gas forecast from The Oil & Gas Journal Aug 2004

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Mike Pacheco

- Director of the National Bioenergy Center (NREL)
- Responsible for coordinating bioenergy research activities

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NREL National Renewable Energy Laboratory

Innovation for Our Energy Future

Renewable Energy: Strengthening Our Nation's Economy

Presented at the Southern California Energy Conference

March 10, 2006

Dr. Michael A. Pacheco
Director, National Bioenergy Center
National Renewable Energy Laboratory

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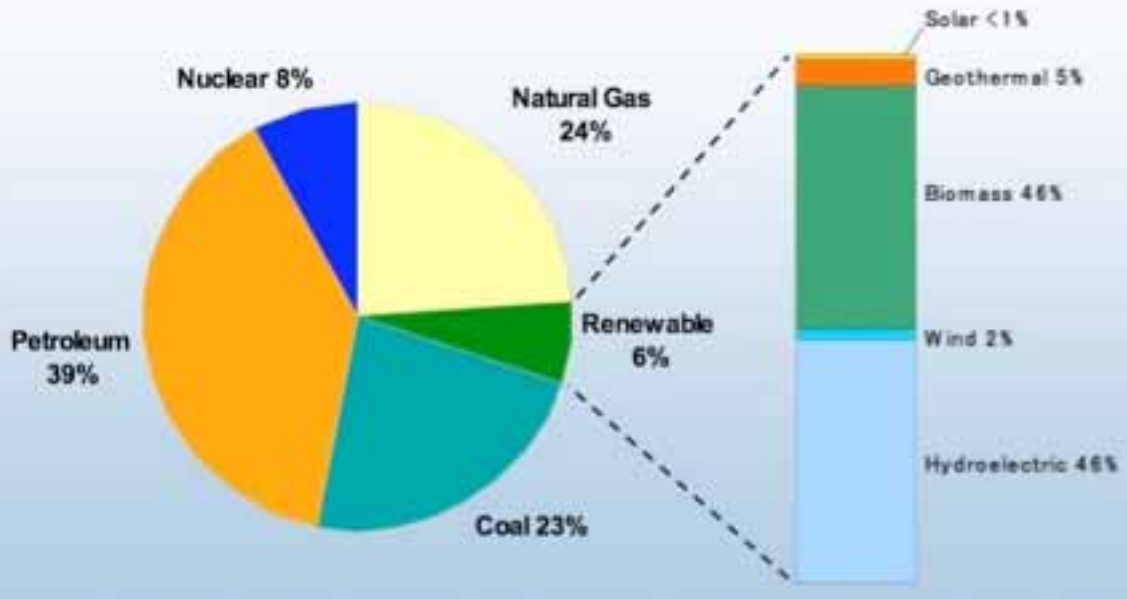
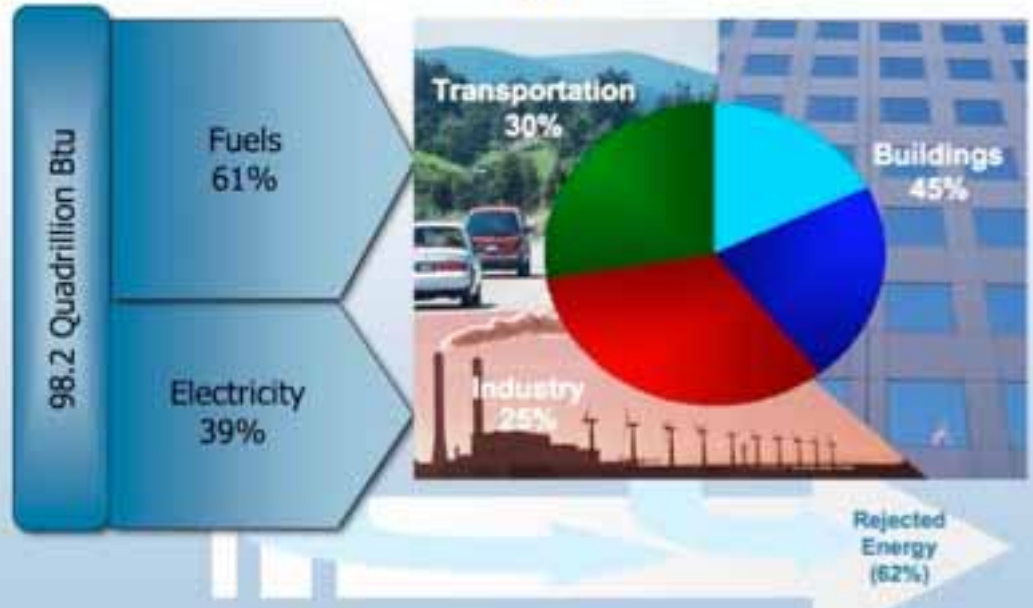
The Role of Renewables in the U.S. Energy Supply - 2003



Source: AEO 2004 tables (released in December 2003) based on US energy consumption. Overall breakdown: Table A1 (Total Energy Supply and Disposition) and Renewable breakdown: Table A18 (Renewable Energy, Consumption by Section and Source)

U.S. Energy Flows



Technology-based Solutions:

There is no single nor simple answer

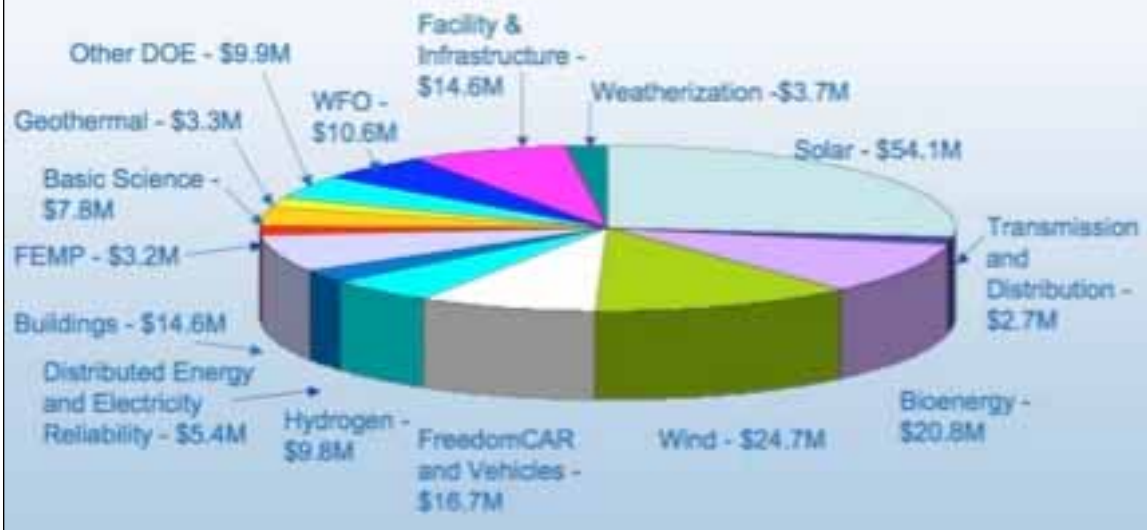
- Energy efficiency
- Renewable energy
- Non-polluting transportation fuels
- Separation and capture of CO_2 from fossil fuels
- Next generation of nuclear fission and fusion technology
- Transition to smart, resilient, distributed energy systems coupled with pollution-free energy carriers, e.g. hydrogen and electricity





NREL FY 2005 Program Portfolio

$201.9 Million



Biomass/Biofuels Status

Biopower

- Grid-connected capacity
  - 9700 MW direct combustion
  - 400 MW co-firing
- Biopower electricity prices generally range from 8-12¢/kWh

Biofuels

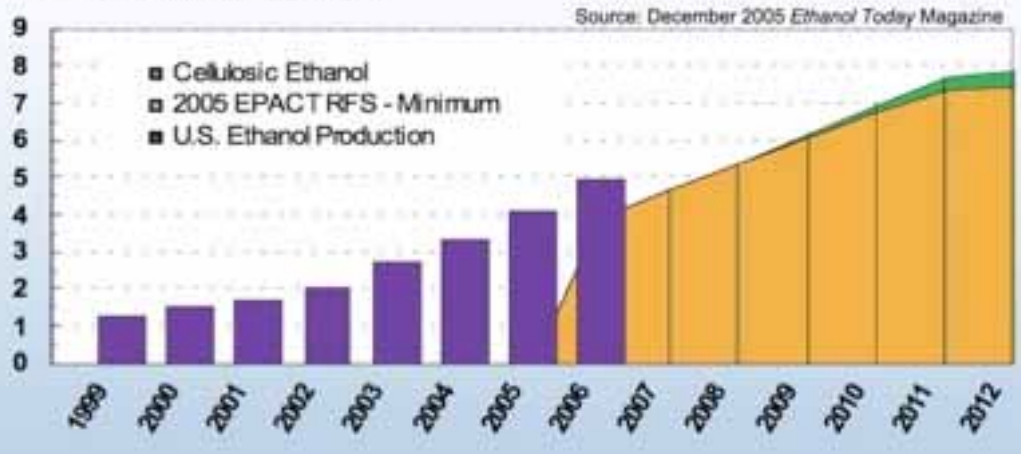
- Biodiesel –
  - 75 million gallons (2005)
- Corn ethanol -
  - 91 commercial plants
  - 4.3 billion gallons (2005)
  - ~$1.20/gal
- Cellulosic ethanol (not commercial)
  - Est. $2 - $3 /gal

Source: U.S. Department of Energy

U.S. Ethanol Production

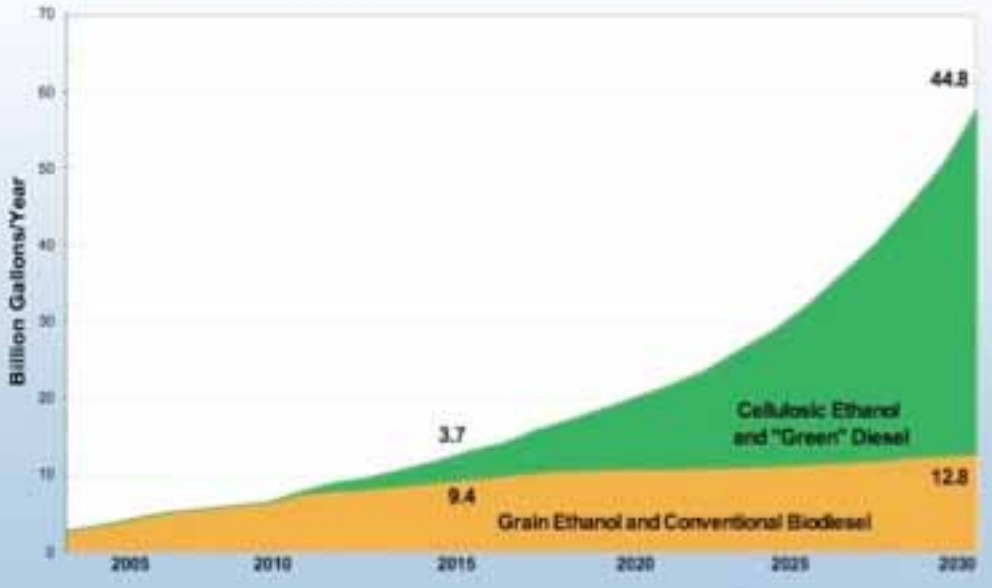
Actual and Projected U.S. Ethanol Production 1999-2012

Billion Gallons of Production



- Renewable Fuels Standard mandates 7.5 billion gallons by 2012
- Total US gasoline market ~140 billion annual gallons

Required Growth of Cellulosic Ethanol to Supply 30% of U.S. Gasoline Demand by 2030



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Energy Efficiency and Renewable Energy Technologies Can Drive Economic Development in California

NREL is a partner in the developing cost-effective renewable resources to support growth of renewable energy industries

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